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MOTOROLA

"DIGITAL PRIVATE-LINE" BINARY-CODED SQUELCH

Theory and Servicing Fundamentals

Reference Manual

68P81106E83–A

MOTOROLA
"DIGITAL PRIVATE-LINE" BINARY-CODED SQUELCH

IMPORTANT

1. This booklet contains the necessary background information for troubleshooting and servicing Motorola "Digital Private-Line" binary-coded squelch circuits. The information will not be repeated in each equipment instruction manual because such background information is unnecessary after an initial familiarization. The equipment manuals will assume that the technician has a background knowledge equivalent to the information presented in this booklet. You may use this booklet to acquire that background.
2. The schematic diagrams and specific circuit data are accurate as of the original printing date of this booklet. However, such information is intended only to aid in understanding basic fundamentals of circuit operation and servicing techniques and no attempt will be made to reprint the booklet to keep abreast of any circuit changes which do not affect basic circuit design. Likewise, no reprinting will be made to add equipment which may be introduced after the original printing of this booklet.
3. This booklet has been widely distributed in an attempt to reach all technicians who may soon be servicing "Digital Private-Line" equipment. Keep the booklet for future training of new technicians. Additional copies may be obtained from Motorola, Inc., Engineering Publications Dept., 1301 East Algonquin Road, Schaumburg, Illinois 60172.

1. INTRODUCTION

1.1 Some years ago Motorola introduced "Private-Line" tone-coded squelch which allows several communications networks to share a single rf channel, while each user receives only messages from his own network. Motorola now introduces "DIGITAL PRIVATE-LINE" BINARY-CODED SQUELCH, which greatly expands the number of private communications networks that may share an rf channel.

1.2 Since "Digital Private-Line" operation is available in most Motorola two-way radio equipment, an understanding of its operation is very important. This booklet provides that explanation. Since most readers are familiar with "Private-Line" tone-coded squelch circuits, this booklet compares "Digital Private-Line" binary-coded squelch with "Private-Line" tone-coded squelch insofar as possible. Additionally, a short review of "Private-Line" tone-coded squelch is included for those not already familiar with its operation.

1.3 "Digital Private-Line" binary-coded squelch and "Private-Line" tone-coded squelch cannot be mixed in the same system; that is, they will not respond to each other since they use a totally different code scheme. However, one system using "Digital Private-Line" and another system using tone "Private-Line" can both use the same rf channel.

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1.4 Each "Digital Private-Line" code is assigned a three-digit identification number; for example, 057, 131, 227, etc. These code numbers are selected by a code plug with the identification number stamped on the outside. Motorola will coordinate the assignment of these codes to users.

2. REVIEW OF "PRIVATE-LINE" TONE-CODED SQUELCH OPERATION

In the familiar "Private-Line" tone-coded squelch systems, a tone signal is used to unsquelch a particular receiver (or receivers) within a system. This PL tone is transmitted continuously by the radio set originating the call and is decoded by the corresponding receiver decoder, unsquelching the audio path. Other receivers operating on the same rf channel, but no sensitive. to the same PL tone, remain squelched. Because the tone is out-of-band it is not heard in the audio.

3. COMPARISON OF "DIGITAL PRIVATE-LINE" OPERATION TO TONE "PRIVATE-LINE" OPERATION

Figure 1 is a block diagram of two basic radio communications systems, one using "Digital Private-Line" binary-coded squelch and the other using "Private-Line" tone-coded squelch. Note that both basic systems are similar except that one system uses a "Digital Private-Line" encoder and decoder and the other uses a tone "Private-Line" encoder and decoder. Although "Digital Private-Line" operation uses a totally different code scheme from the tone "Private-Line" operation, many features are directly comparable. Both tone and "Digital Private-Line" squelch systems perform the function of unsquelching the receiver upon receipt of a coded signal. Comparison of similar functions are described below.

3.1 SIGNAL DECODING

3.1.1 In a tone "Private-Line" system a specific tone frequency in the 67 to 210 Hz range is detected; whereas, in a "Digital Private-Line" system a specific binary code word is decoded. In both systems the decoding process results in a voltage output which unsquelches the receiver. In both systems the code signal (tone or binary) is transmitted continuously during the transmit cycle.

3.1.2 In a tone "Private-Line" system, a highly selective "Vibrasponder" resonant reed detects the code tone, resulting in an unsquelched receiver. In a "Digital Private-Line" system, a programmed integrated circuit decoder decodes the receiver binary code, resulting in an unsquelched receiver.

3.2 INAUDIBLE CODE SIGNAL

Audio filters in Motorola transmitters and receivers limit the voice response to the 300 to 3000 Hz range. In both the tone "Private-Line" and "Digital Private-Line" systems the code signal frequency is below 300 Hz; therefore, is out-of-band. Because of this, the signals are inaudible even though they are continuously transmitted.

3.3 DISABLING

Since the operator of a "Private-Line" radio does not hear all the messages on the rf channel, the operator must somehow check that the rf channel is not in use by another party before transmitting. In both tone "Private-Line" and "Digital Private-Line" systems, a "PL" DISABLE or MONITOR switch allows the operator to bypass the "Private-Line" decoder and any on-channel signals will be heard in the speaker. The "Private-Line" disable switch may be part of the microphone hang-up box or a separate switch, but in any case is fully identical for tone "Private-Line" or "Digital Private-Line" radios.

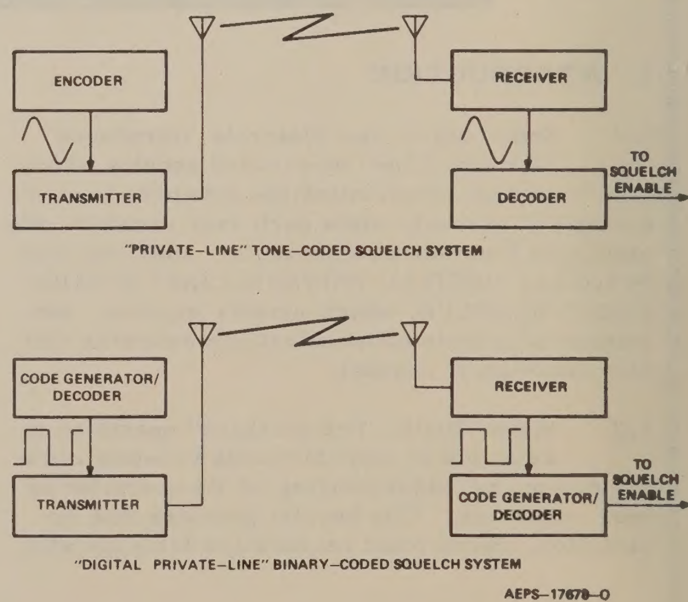


Figure 1.
Basic Coded "Private-Line" Squelch Systems

3.4 TRANSMIT/ENCODE

In a tone "Private-Line" system, a "Vibrasender" resonant reed generates a precise code tone; whereas, a programmed integrated circuit generates the binary code word in "Digital Private-Line" systems. In each case, the signal is transmitted continuously during the push-to-talk cycle and continues for a short period after the push-to-talk switch is released.

3.5 SQUELCH TAIL ELIMINATOR

In carrier squelch systems, a squelch tail is heard in the audio whenever the transmitter is unkeyed. The squelch tail results because the increase in receiver noise, caused by loss of carrier, must charge rc networks before squelch occurs. The receiver audio output contains high noise upon loss of carrier and then tails off to a no-noise condition until actually squelched. To eliminate "squelch tails" at the end of transmission, the tone "Private-Line" system transmits a reverse burst (out-of-phase) tone when the transmitter is unkeyed. The reverse burst stops the "Vibrasponder" reed from vibrating to squelch the receiver before the transmitter turns off. Similarly, the "Digital Private-Line" system transmits a turn-off code when the transmitter is unkeyed. The turn-off code is detected by all decoders (all "Digital Private-Line" decoders decode the turn-off code regardless of code plug) and all "Digital Private-Line" receivers (on the same rf channel) are immediately squelched without "squelch tails" being heard.

3.6 REEDS VS CODE PLUGS

In "Private-Line" tone-coded systems, resonant reeds are used to generate (encode) the tone at the transmitter and to decode the particular tone at the decoder, unsquelching the receiver. In some systems (simplex or duplex) two reeds are required, one for encoding and one for decoding. However, in most "Digital Private-Line" systems, the same code plug is used to program both the encoder (transmitter end) and the decoder (receiver end). Normally, both the encoder and decoder binary codes are identical; therefore, one code plug will service to program both. Code changing is simply accomplished by removing one code plug and inserting another. Thus a radio set used in one "Digital Private-Line" system can be readily adapter to another system by changing the code plug.

3.7 ADDED FEATURES

Because the "Digital Private-Line" system uses a binary-coded signal, totally solid-state integrated circuits can be used and more codes can be generated. With the use of integrated circuits overall component reliability increases. With more codes available, each rf channel will service more users. A low pass filter sharply attenuates frequencies above 90 Hz, thereby preventing audible harmonics of the code from being transmitted. Because of the filter characteristics, the digital signals are not heard even in carrier squelch radios.

4. CIRCUIT DESCRIPTION

4.1 INTRODUCTION

The basic configuration used in "Digital Private-Line" binary-coded squelch is the simplex system which is described in detail. There are other "Digital Private-Line" binary-coded squelch configurations such as two code simplex, duplex and multiple code, but these also use the same basic circuit configuration. After the basic simplex system configuration is described, each of the additional configurations is also described. Variations in interface circuits and the physical construction allow the same basic circuit design to be used in various equipments.

4.2 SIMPLEX "DIGITAL PRIVATE-LINE" SYSTEM

4.2.1 Refer to Figure 2, Basic Simplex "Digital Private-Line" System. In any simplex radio system, keying the transmitter disconnects the receiver; therefore, transmit and receive functions are never simultaneous. Similarly, in simplex "Digital Private-Line" operation the code cannot be transmitted and received simultaneously. Because of this a simplex "Digital Private-Line" system requires only one code plug in each radio set.

4.2.2 In the application of Figure 2, the push-to-talk function is applied to the "Digital Private-Line" encoder circuits. This immediately produces delayed keyed A+ and activates the encoder circuit. With the encoder activated, the binary code is applied to the exciter as long as the PTT function is applied, and the binary code is transmitted.

NOTE

During this time the receiver is disconnected at the antenna switch.

The rf carrier modulated by the binary code is then received by all receivers tuned to the same frequency as the transmitter; however, only the receiver(s) which decode the binary signal (or carrier squelch receivers) will actually become unsquelched.

4.2.3 When the rf signal is received at the distant radio, the receiver discriminator output contains the binary code word which is applied to the "Digital Private-Line" decoder for decoding. The decoder then provides a squelch enable output that unsquelches the audio circuit. Once the audio circuit is unsquelched, received audio passes to the speaker (headset, handset, etc.). The receiver remains unsquelched as long as the binary code word is received.

4.2.4 When the push-to-talk function is removed at the transmitter, the encoder circuits are deactivated; however, delayed keyed A+ remains applied to the exciter for approximately 180 milliseconds. During this 180 millisecond time period, the "Digital Private-Line" encoder generates a series of symmetrical square waves which are used as a turn-off code. The turn-off code is decoded at the distant radio "Digital Private-Line" decoder and the audio circuit is squelched immediately.

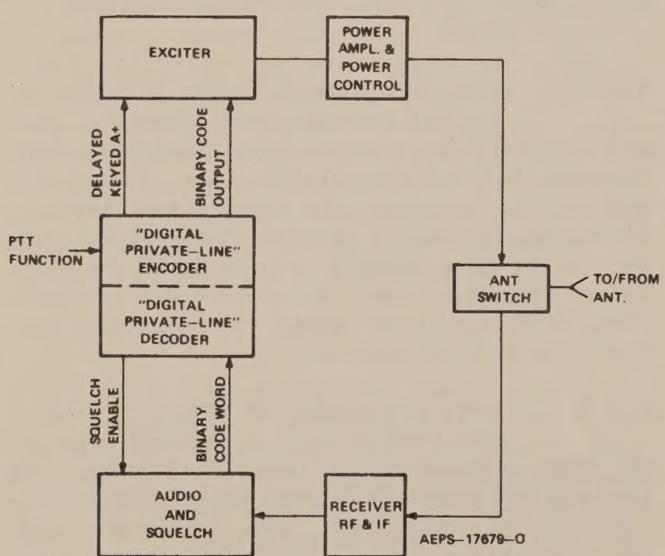


Figure 2.
Basic Simplex "Digital Private-Line" System

4.3 TYPICAL SIMPLEX ENCODING & DECODING PROCESS

Figure 3 provides a functional block diagram of a typical simplex "Digital Private-Line" encoder and decoder. The basic simplex system building blocks are the same in all mobile and base station radios and the blocks are described below in their circuit operating order. The basic simplex system building blocks in portable radio sets are somewhat different than in mobile and base station radios, and a separate block diagram description is given in paragraph 4.4.1.

4.3.1 Decoding Process

4.3.1.1 Low-Pass Active Filter

The low-pass filter accepts an input signal (binary code word from discriminator) which contains the binary code word and audio signals. The active filter attenuates frequencies above 140 Hz (noise and voice signals) and allows the low frequency binary signals to pass to the data conditioner.

4.3.1.2 Data Conditioner

The data conditioner (an integrated circuit) squares up the code word bits and applies them via the switch/level shifter to the code generator/decoder. Once the code word is decoded, the data conditioner sensitivity increases because of the precision current source being disabled (see paragraph 4.3.1.5 for further explanation).

4.3.1.3 Code Generator/Decoder

The code generator/decoder (an integrated circuit) works in conjunction with the timing oscillator control circuits, code plug, and resistive network to decode a particular incoming code word.

4.3.1.3.1 The timing oscillator control circuits contain a series connected crystal and FET in the oscillator feedback path. The crystal determines the 50 kHz frequency at which the timing oscillator operates. The timing oscillator (part of which is inside the integrated circuit) produces the timing clock for the decoding and encoding process.

4.3.1.3.2 The code plug, together with the resistor network, determines the specific code word to which the decoder responds.

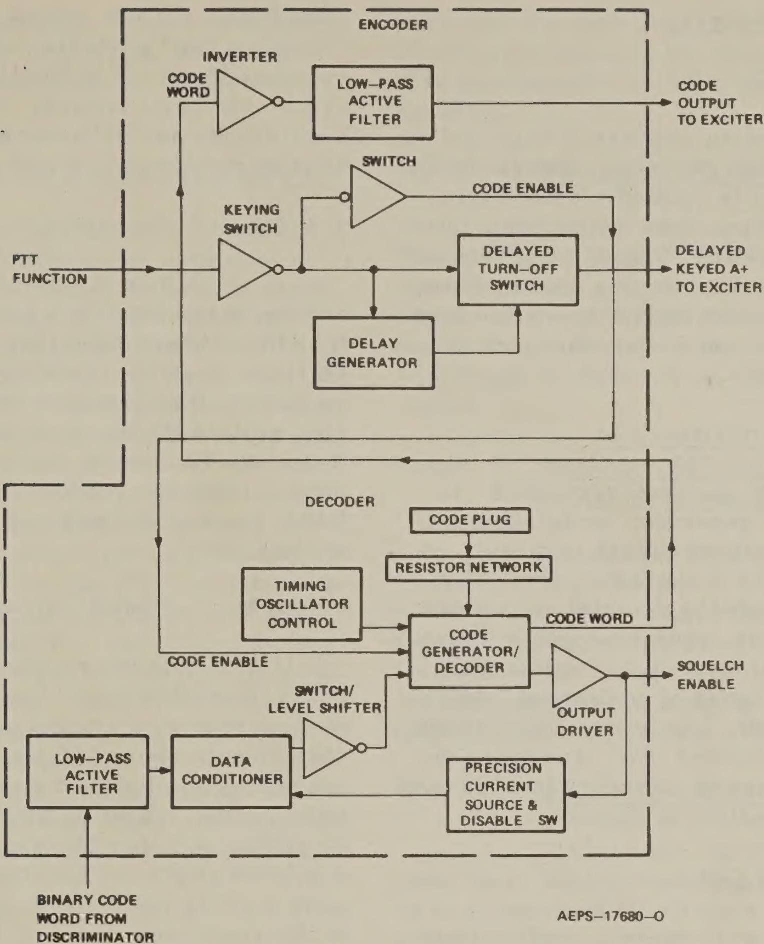


Figure 3.
Simplex "Digital Private-Line" System
Block Diagram

The code identification number is stamped on the code plug body.

4.3.1.4 When the code generator/decoder decodes an incoming code word, it provides an output (high logic level) to the output driver stage. The output driver then furnishes a high output on the squelch enable line which is used to unsquelch the audio circuits. A second output from the output driver is applied to the precision current source (via the disable switch).

4.3.1.5 Precision Current Source

The precision current source is disabled as soon as a valid code word is detected. Once the precision current source is disabled, the data conditioner operation is changed, resulting in increased sensitivity. The increased sensitivity provides additional immunity to audible interference. A delay circuit holds the precision current source disabled for approximately one second after loss of signal. This delay provides the higher data conditioner sensitivity for the duration of possible fades.

4.3.1.6 Turn-Off Code

At the end of push-to-talk, the encoder (at the transmitter) generates a turn-off code which lasts for approximately 180 milliseconds. This code is decoded at the receiver end and causes the squelch enable output to become low. This low immediately squelches the receiver and applies a turn-on signal to the precision current source. With the squelch enable output low, squelch tails are eliminated from the audio output circuit. However, the turn-on signal to the precision current source is delayed for approximately one second but should have no effect on the receiver since it is already squelched.

4.3.2 Encoding Process

4.3.2.1 Keying Circuit

The encoding process is initiated by the push-to-talk function generating delayed keyed A+. The PTT function is applied via the keying switch to produce a low input to a switch transistor and delayed turn-off switch. The delayed turn-off switch produces a keyed A+ for the exciter to activate the transmitter circuits and the switch transistor produces a code enable for the code generator/decoder circuit.

4.3.2.2 Code Word Generator

The code generator/decoder is switched into the code generator mode whenever the code enable line voltage is high (a result of push-to-talk). With the code enable line high, the code generator produces a serial code word output. The serial code word is applied to an inverter in the encoder section and a low pass active filter (in some types of equipment, the inverter stage is omitted). The active filter output is then applied to the exciter for transmission. The code word continues to be transmitted as long as the push-to-talk function is applied.

4.3.2.3 Turn-Off Code

When the push-to-talk function is removed, the code enable line becomes low (ground), causing the code generator to produce the turn-off code (a series of symmetrical square waves). This code is then applied via the active filter to the exciter for transmission; however, it is transmitted only while delayed keyed A+ is still applied to the exciter. Delayed keyed A+ remains applied for approximately 180 milliseconds after the push-to-talk function. This delayed keyed A+ is a result of the delay generator holding the turn-off switch on. Thus for 180 milliseconds after push-to-talk the turn-off code is transmitted, eliminating squelch tails by squelching the receiver audio path.

NOTE

The effect produced by the turn-off code is similar to the reverse burst in tone "Private-Line" encoders.

4.4 APPLICATIONS

4.4.1 Portable Radios

4.4.1.1 Comparison to Mobile Radio Circuits

Figure 4 is a functional block diagram of the "Digital Private-Line" encoder and decoder used in the MX300 series portable radios and "Handie-Com" portable radios. The reader may compare Figure 3 to Figure 4, along with their associated explanations, to denote the major similarities and differences between the circuits used in mobile radios and portable radios.

4.4.1.2 Packaging

The "Digital Private-Line" encoder and decoder circuit in a portable radio consists of four thick film hybrid plug-in modules. In Figure 4A these modules are identified as code conditioner module U133, processor module U132, code plug module U134 and encode filter module U131. In Figure 4B, these modules are identified as code conditioner module U401, processor module U402, code plug module U404 and encode filter module U403.

4.4.1.3 Code Conditioner Module

In the receive mode, recovered audio is applied to pin 1 of the code conditioner module where an active, low-pass filter attenuates signals above 150 Hz. The remaining signal (code) is amplified and applied to an amplitude limiter. Test point pin 5 is provided at the amplifier output. The amplitude limited code is available at pin 6. The logic convention for the code word is such that an increase in frequency at the receiver antenna is recognized as a logic one (high) at pin 10 of the code conditioner. An inverter accommodates both low and high side receiver mixer injection to maintain the logic convention at pin 10. The purpose of the phase lock loop (PLL) circuit is to sense the incoming frequency and to lock onto the code word. Initially, before a code is detected, the PLL functions in a low sensitivity mode and permits only a percentage of the code word to be presented by the decoder. When a valid code is detected by the decoder, a detect signal appears as a logic high at pin 13 of the code conditioner, and remains high while the correct code is present. Upon detecting the high level, the control circuit changes the PLL to a higher sensitivity mode and permits all of the code to be applied to the decoder. The voltage at pin 12 then drops low and unsquelches the receiver. The higher sensitivity mode provides additional immunity to audible interference when the detected code is present. Should the receiver momentarily lose data because of flutter, fade or poor quieting, the switching circuit will hold the PLL in the higher sensitivity mode for approximately 500 milliseconds after loss of code detect. With the PL switch in the off position, B+ is applied to pin 14 and causes pin 12 to be low, effectively defeating or

overriding the decode function. The switch does not, however, effect the processor, and the encoder will always produce code in the transmit mode.

4.4.1.4 Processor and Code Plug Modules

In the receive mode, the decoder logic receives and continuously samples data at pin 10. The decoding scheme is a basic system of comparing the incoming data with the preselected code stored in the code plug module. The processor, which employs MOS/LSI logic, contains a 50 kHz crystal controlled oscillator to provide timing (clock) pulses which control the logic in both the receive and transmit modes. In the transmit mode, the PTT switch activates transmit/receive relay K101 and applies ground to pin 15. A 23 bit binary code word is produced by the encoder at pin 12. When the PTT switch is released, the current path through relay coil K101 is maintained through pin 14 of the processor for 120 milliseconds. The length of time is controlled by a timer in the processor. During the 120 milliseconds, the crystal controlled 134 Hz square wave is gated to pin 12, passed through the encode filter module, and is transmitted. The receiving radio's decoder recognizes the 134 Hz signal as a turn-off code, and the receiver is immediately squelched.

4.4.1.5 Encode Filter Module

The encode filter contains an amplifier, an active low-pass filter, and an inverter which are used only in the transmit mode. The code from pin 12 of the processor (typically 5 volts peak-to-peak) is coupled through an R-C coupling network to pin 1 of the encode filter. The code is then amplified and filtered to remove higher order audible components. This causes the corners of the coded output pulses to be slightly rounded. Overall module gain is -10 dB; typical output amplitude is 1-volt peak-to-peak. The filtered code (pin 2 for MX300 radios and pin 5 for "Handie-Com" radios) is applied to the modulating port of the transmitter channel elements.

4.4.2 "Micor" Mobile Radio

Circuits for the simplex "Digital Private-Line" binary-coded squelch system used in "Micor" mobile radio sets are contained on two circuit boards; a decoder board and an encoder board. Schematic diagrams of the decoder and encoder used in "Micor" mobile radios are included in this booklet. Theory and maintenance information is contained on the diagrams in the same format in which it appears in the equipment manual. Note that the code generator/decoder integrated circuit is located on the decoder board, although it is functionally used as the code generator while encoding.

4.4.3 "Mocom • 70" Mobile Radio

Circuits for the simplex "Digital Private-Line" binary coded squelch system encoder/decoder are contained on a single circuit board and are switched from the decode to the encode mode whenever the transmitter is keyed. A schematic diagram of this circuit is also included.

4.4.4 "Mocom • 10" and "Mocom • 35" Mobile and Base Station Radios

Circuits for the simplex "Digital Private-Line" binary-coded squelch system encoder/decoder are contained on a single circuit board and are switched from decode to encode whenever the transmitter is keyed. The schematic diagram for this encoder/decoder is similar to the one included for the "Mocom • 70" radio.

4.4.5 "Maxar" Mobile and Base Station Radio

Circuits for the simplex "Digital Private-Line" binary-coded system encoder/decoder are contained on a single circuit board and are switched from decode to encode whenever the transmitter is keyed. The schematic diagram for this encoder/decoder is also similar to the one included for the "Mocom • 70" radio.

4.4.6 Base Station

4.4.6.1 "Consolette" Base Stations

Circuits for the "Digital Private-Line" binary-coded squelch used in "Consolette" base stations are very similar to those used in the "Mocom • 70" mobile radio.

4.4.6.2 "Micor" Base Stations

Circuits for the simplex "Digital Private-Line" binary-coded squelch system used in "Micor" base stations are contained on two circuit boards; a decoder and encoder. The decoder board is the same one used in the "Micor" mobile radio. The encoder board is very similar to the "Micor" mobile encoder except for lack of a code enable output line. This is because in the "Micor" base stations, keyed A+ is applied to both the decoder and encoder when the push-to-talk function is initiated.

4.5 TWO CODE SIMPLEX

4.5.1 General

In normal simplex system applications, only one code is used; that is, the same code is transmitted (encoded) as is received (decoded). However, most mobile radios are available that can transmit a different code than they receive (two code simplex system). In this application, two different code plugs are connected to the code generator/decoder integrated circuit through a diode matrix. One code plug is switched in during receive time and the second code plug is switched in during transmit time. Thus, the transmitted code is always different from the received code.

4.6 DUPLEX "DIGITAL PRIVATE-LINE" SYSTEM

4.6.1 General

A duplex radio system is one in which transmission and reception can take place simultaneously. In a duplex system, therefore, two different code generator/decoder integrated circuits must be used. Such circuits will be found in "Micor" repeaters and full duplex base stations.

4.6.2 Decoder

The decoder used in a duplex "Digital Private-Line" system is the same simplex decoder used in "Micor" mobile radios. In a duplex decoder application a jumper is connected to prevent the code generator from functioning, however, decoding is the same as in the simplex system.

4.6.3 Encoder

The encoder used in a duplex "Digital Private-Line" system is the TLN5725A Duplex Encoder. This encoder is shown on an accompanying schematic diagram. This circuit includes a code generator integrated circuit which operates entirely independent of the generator/decoder IC on the decoder board.

4.6.4 One-Code Duplex System

The duplex decoder and encoder can be used in base station and repeater applications which are part of a simplex system which transmit and receive the same code. In these applications, the duplex station is compatible with the simplex system provided identical code plugs are used in both the decoder and encoder. With identical code plugs, the duplex station fits into the simplex system because it transmits (encodes) and receives (decodes) the same code word.

4.7 MULTIPLE CODE ENCODER SYSTEM

Multiple "Digital Private-Line" applications are similar to those described for simplex systems except: the encoder contains multiple code plugs which are controlled by multiple front panel switches. In this manner a different code plug and, consequently, a different binary code is selected by each switch. Once the switch is depressed, operation is the same as described for simplex.

NOTE

The switches change the transmitted code only.

5. MAINTENANCE

5.1 TRANSMITTER SERVICING NOTES

5.1.1 Code Disable

5.1.1.1 For some transmitter tests and adjustments such as checking transmitter frequency, it is necessary to generate an unmodulated transmitter carrier signal. In "Digital Private-Line" radios, an unmodulated transmitter carrier signal can be obtained only if the "Digital Private-Line" code is disabled. In mobile and base station radios this is accomplished by shorting together the two code disable pins or points on the encoder circuit board. In portable radios, the "Digital Private-Line" encoder is disabled by unplugging a module or modulator input lead.

5.1.1.2 In "Micor" mobile radios and base stations with simplex encoders, the code disable pins are identified as J701 and J702. These pins are located in the base circuit of Q702 as shown in Figure 6 and Figure 8. In "Micor" base stations with duplex encoders, the code disable pins are identified as J702 and J703 in the base circuit of Q702 per Figure 8. In "Mocom 70" mobile radios and "Consolette" base stations, the code disable points are located in the collector circuit of Q803 per Figure 9. In other mobile equipment, the code disable pins or points are similarly located in the "Xmit Code Output" signal path where shorting the pins or points together will short out the code signal. In MX300 portable radios, unplug encode filter module U131. In

"Handie-Com" portable radios, disconnect modulator lead P11 for high band radios or P2 for low band radios.

5.1.2 FM Deviation

Transmitter deviation should be ±0.5 to 1 kHz with only "Digital Private-Line" code modulation applied, the same as for "Private-Line" tone-coded modulation. Likewise, the maximum deviation with both audio and code modulation applied should be ±5 kHz. Transmitter deviation is measured in the standard manner using a peak reading deviation meter. The only special requirement, but a very important one, is that the test equipment must have a low frequency response of 1 Hz or less. An accurate deviation measurement cannot be obtained if the test equipment does not meet this requirement (reading will be high). See the test equipment considerations in paragraph 5.2.3.

5.2 TEST EQUIPMENT

5.2.1 "Digital Private-Line" Test Set

5.2.1.1 A Motorola Model SLN6413A "Digital Private-Line" Test Set is required for testing and troubleshooting. The test set contains a separate "Digital Private-Line" encoder and decoder, and both may be used simultaneously if necessary. Thumbwheels on the front panel allow any possible code word to be programmed into the test set. Additionally, separate code plug sockets are provided for both the encoder and decoder sections of the test set so that code plugs can be used to program the code word into the test set.

5.2.1.2 The test set can be used for both signal substitution and signal tracing methods of troubleshooting. The test set encoder generates any possible "Digital Private-Line" code word for injection into the equipment being tested. A PTT switch on the test set places the encoder into the transmit mode whenever desired, and can be locked in the transmit mode for continuous code generation. A level control adjusts the output signal level.

5.2.1.3 The test set decoder gives a visual indication if the point of measurement contains the proper code word signal, and can thus be used for many signal tracing measurements.

5.2.1.4 Front panel switches allow the encoder output signal and decoder input signal to be inverted, if necessary, to match the signal polarity required by the equipment under test.

5.2.2 RF Signal Generator

To generate rf test signals that are modulated by "Digital Private-Line" binary-coded signals, the rf signal generator must be capable of accepting external modulation at frequencies of less than 1 Hz (essentially dc modulation). The Motorola Model S1318A FM Signal Generator and the signal generator in the S1327B Service Monitor meet this requirement. The signal generator in the S1327A Service Monitor may be modified to meet this requirement. A field bulletin will be issued covering more details on the modification.

5.2.3 Deviation Meter

5.2.3.1 The deviation measuring equipment must have a low frequency response of less than 1 Hz to measure deviation with "Digital Private-Line" code modulation. A Motorola Model S1327A or S1327B Service Monitor with modified SLN6350A Deviation Meter Plug-In Module and modified SLN6351A Oscilloscope Plug-In Module or equivalent must be used to meet this requirement. Future shipments of the plug-in modules will include the necessary modifications. The unmodified plug-in modules must be modified for "Digital Private-Line" deviation measurements. A field bulletin will be issued covering full details of the modification.

5.2.3.2 In some rf signal generators, "Digital Private-Line" code modulation is inverted with respect to other rf signal generators. In still other signal generators, inversion occurs only on certain frequency bands. Both normal and inverted code signals are available from the "Digital Private-Line" test set for modulating the rf signal generator and the correct polarity can be selected to compensate for any inversion within the signal generator. For each frequency band and type of radio being tested, it is good practice to note whether normal or inverted code is required for your signal generator. Knowledge of these normal test conditions allows a technician to easily identify any radio that is improperly jumpered to the wrong code polarity. Without knowledge of the normal test polarity, such a problem is difficult to identify.

5.2.4 Oscilloscope and Multimeter

In addition to a "Digital Private-Line" test set, a general purpose oscilloscope is required for waveform measurements and signal tracing. DC coupling must be used for observing

the digital code waveforms. A high impedance multimeter is required for conventional voltage and resistance measurements.

5.3 TROUBLESHOOTING

5.3.1 Board Substitution

Whenever a "Digital Private-Line" trouble occurs, the fastest method of placing the equipment back into operation is to replace the entire radio with a known good spare or to replace a suspected faulty circuit board with a known good spare. The faulty unit may then be returned to the maintenance shop for bench troubleshooting. The spare board substitution technique not only returns the equipment to operation, it quickly isolates the trouble by verifying whether or not the suspected circuit board is faulty. The spare board substitution method is highly recommended over on-site troubleshooting and repair for base and repeater stations or other radios which might affect many users. A faulty mobile or portable radio usually affects only one user, whereas a base or repeater station usually affects many users.

5.3.2 Bench Troubleshooting

Bench troubleshooting comprises the tests and procedures necessary to isolate and replace malfunctioning parts in "Digital Private-Line" circuits. If spare equipment is not available and on-site troubleshooting is required, the procedures are the same as for bench troubleshooting. To test faulty circuit boards they should be installed in an operating radio for bench testing to provide the necessary interconnections and circuit loading. Recommended troubleshooting procedures are given in the following paragraphs for several "Digital Private-Line" circuit boards.

5.4 BASIC TROUBLESHOOTING TECHNIQUE

5.4.1 The fundamental technique of using the "Digital Private-Line" test set to isolate a fault is basically the same for all models of "Digital Private-Line" decoders, although there are necessarily differences in points of measurement, signal levels and signal polarity. Likewise, the sequence of testing all models of "Digital Private-Line" encoders is fundamentally the same. This booklet contains specific troubleshooting procedures for several models of "Digital Private-Line" circuits. This permits the reader to compare steps that are similar, thus defining the fundamental techniques in an actual application. The reader may also compare differences between the procedures, thus becoming aware of certain tests that are likely to be different for each model.

5.4.2 The procedures consist of a series of tests which localize any fault to a confined area; a normally operating unit will pass all the tests. By analyzing the accompanying schematic diagrams along with the testing procedures, the faulty area that will result from each test failure is easily defined. The procedures attempt to restrict the tests to those that are specialized for "Digital Private-Line" circuits. Trouble isolation to the specific bad component requires conventional troubleshooting techniques of waveform, voltage and resistance measurements within the faulty area. Procedures which require conventional troubleshooting techniques are not included.

5.5 "MICOR" MOBILE RADIO AND BASE STATION

5.5.1 General

"Micor" mobile radio sets and base stations with "Digital Private-Line" binary-coded squelch require two plug-in circuit boards. In simplex systems, the decoder board contains the code generator and decoder circuits and the encoder contains only circuits which interface the code generator with the transmitter exciter. In duplex base stations and repeaters, the same decoder board is used as in simplex systems except that a jumper is changed to permanently disable the encode mode of operation. The encoder board contains its own code generator and is entirely independent of the decoder board. Suggested methods for troubleshooting the circuits are discussed below.

5.5.2 "Micor" Decoder
(Refer to Figure 5)

Step 1. Use the "Digital Private-Line" test set to check that the code plug is not defective.

NOTE

If the code plug is normal, the recommended procedure is to insert the code plug into a "known-good" decoder board and replace the defective decoder board.

Step 2. Using an oscilloscope, check for a 50 kHz clock signal at U801-4 of the code generator/decoder integrated circuit.

Step 3. Be sure that the receiver sensitivity is within specification. Perform the 20 dBq sensitivity check if not sure.

Step 4. Connect the test equipment as for the 20 dBq sensitivity check, except set the rf signal generator to 1000 microvolts.

Step 5. Connect the "Digital Private-Line" test set CODE OUT signal to frequency modulate the rf signal generator. Set the test set LEVEL control for ±750 Hz deviation output from the rf signal generator.

Step 6. Set the test set thumbwheel code switch to the same code as the decoder code plug of the radio under test. Set both ENCODE SELECT and DECODE SELECT switches on the test set to select the thumbwheel.

NOTE

Be sure that the test set CODE OUT INVERTED-NORMAL switch is set to the correct position, that the thumbwheel switch is set to the correct code (same as radio set code plug), and that the ENCODE SELECT switch is set to select the thumbwheel setting. The CODE OUT INVERTED-NORMAL switch position depends upon several variables; e.g., type of signal generator used, exact point in the radio set at which the signal is decoded by the test set, and jumper connections in the decoder.

Step 7. Connect a test lead to the CODE IN jack of the test set. Touch the test lead probe to pin 4 of the "Digital Private-Line" decoder board. Check that the test set DECODE indicator lights.

NOTE

It may be necessary to reverse the test set CODE IN INVERTED-NORMAL switch position. Failure to decode in Step 7 indicates that the code signal is not getting through the receiver to the decoder board.

Step 8. Move the CODE IN test lead probe to Q804 collector and check that the DECODE indicator lights.

Step 9. Move the CODE IN test lead probe to Q806 base and check that the DECODE indicator lights.

Step 10. Reverse the test set CODE IN INVERTED-NORMAL switch position so it is opposite to step 9. Move the CODE IN cable probe to Q806 collector and check that the DECODE indicator lights.

Step 11. Check for a logic high at U801-7. If U801-7 is a logic low, set the test set CODE OUT INVERTED-NORMAL switch to the opposite position and check for a logic high.

Step 12. If the results of Step 10 are normal but U801-7 is still a logic low in Step 11, then check code generator/decoder U801 as follows:

a. Check U801-1 for 0 V dc.
b. Check Z801 and the code plug for proper connections, solder shorts, open circuit, etc.
c. Check U801-7 for a short to ground.

Step 13. Decrease the rf signal generator output level to zero and slowly increase it until the meter 11 position indication is 1.0 V (6 dBq level).

Step 14. Check for a logic high at U801-7.

Step 15. Slowly decrease the rf signal generator output until the meter 11 position indication is 1.26 V (4 dBq level). Check that the logic high still exists at U801-7.

Step 16. If U801-7 changes to a logic low in Step 14, code sensitivity is low. Check the precision current source. Refer to the radio set instruction manual for further information.

5.5.3 "Micor" Simplex Encoder
(Refer to Figure 6 and 8)

5.5.3.1 General

When checking a simplex encoder while it is still connected in the radio set, terminate the transmitter output into a dummy load rather than the antenna. Because part of the simplex encoder circuits are mounted on the decoder board, both boards must remain connected in the radio set.

5.5.3.2 Encoder Circuit

Step 1. With an oscilloscope, check that the waveform at pin 6 (code input) of the simplex encoder board is a 134 Hz symmetrical square wave (approximately 6 V p-p).

NOTE

If the waveform is not correct, check for a 50 kHz clock signal at pin 4 of the code generator/decoder on the associated decoder board.

Step 2. Check for a 3 V p-p (1.6 V p-p in high band mobile radios) sine wave at Q704 collector (Q703 emitter in high band mobile radio).

Step 3. Set the "Digital Private-Line" test set thumbwheel code switch to the same code as the code plug (mounted on the decoder board), and set the DECODE SELECT switch to select the thumbwheel.

Step 4. Connect a test lead to the test set CODE IN jack. Touch the test lead probe to J703 (on the encoder board) and key the radio set. Check that the test set DECODE indicator lights.

NOTE

If indicator does not light, it may be necessary to reverse the test set CODE IN INVERTED-NORMAL switch position. Also, check that Q705 collector voltage is +9.6 V dc.

Step 5. Move the CODE IN cable probe to Q704 collector (on the encoder board) and key the radio. Check that the test set DECODE indicator lights.

NOTE

The test set CODE IN INVERTED-NORMAL switch should be set opposite to that of Step 4.

5.5.3.3 Delayed Keyed A+ and Code Enable Switch Circuit

Step 1. Key the radio and check that filtered A+ immediately appears at Q708 collector.

Step 2. Unkey the radio and check that filtered A+ remains at Q708 collector for 170-250 milliseconds.

Step 3. ("Micor" Mobile radios only) Key the radio and check that +9.6 V appears at Q705 collector 20-40 milliseconds after keyed A+ appears at pin 2 (Q706 turns on).

5.5.4 "Micor" Base Station Duplex Encoder (Refer to Figure 7)

5.5.4.1 General

When checking a duplex encoder while it is still connected in the equipment, terminate the transmitter output into a dummy load rather than the antenna. All the duplex encoder circuits are mounted on one plug-in board in the duplex application and operate independently from the decoder.

NOTE

In some simplex systems the base station might be equipped with a duplex encoder. If the system requires that the same code word be used for encoding and decoding, then the encoder and decoder code plugs are identical.

5.5.4.2 Encoder

Step 1. With an oscilloscope check that the waveform at U701-5 is a 134 Hz symmetrical square wave (approximately 6 V p-p).

NOTE

If waveform is not correct check for a 50 kHz clock signal at pin 4 of the code generator/decoder (U701).

Step 2. Check for a 3 V peak-to-peak sine wave at Q704 collector.

Step 3. Set the "Digital Private-Line" test set thumbwheel switch to the same code as the encoder code plug. Set the DECODE SELECT switch to select the thumbwheel.

Step 4. Connect a test lead to the CODE IN jack on the test set. Touch the probe of the test lead to J704 and key the station. Check that the test set DECODE indicator lights.

NOTE

It may be necessary to reverse the test set CODE IN INVERTED-NORMAL switch position.

Step 5. Move the probe of the CODE IN test lead to Q704 collector and key the station. Check that test set DECODE indicator lights.

NOTE

The test set CODE IN INVERTED-NORMAL switch should be set opposite to that of Step 4.

5.5.4.3 Delayed Keyed A+ Circuit

Step 1. Key the station and check that filtered A+ immediately appears at Q708 collector.

Step 2. Unkey the station and check that filtered A+ remains at Q708 collector for 170-250 milliseconds.

5.6 "MOCOM • 70" MOBILE RADIO SET AND "CONSOLETTE" BASE STATIONS

5.6.1 General

"Mocom • 70" mobile radio sets and "Consolette" base stations with "Digital Private-Line" binary-coded squelch have one circuit board to mount both the encode and decode circuits. Suggested methods for troubleshooting the decode and encode circuits are discussed below.

5.6.2 Decoder Circuit
(Refer to Figure 9)

Step 1. Use the "Digital Private-Line" test set to check that the code plug is not defective.

NOTE

If the code plug is normal, the recommended procedure is to insert the code plug into a "known-good" encoder-decoder board and replace the defective board.

Step 2. Using an oscilloscope, check for a 6 volt, 50 kHz square wave with a rise time of less than 750 nanoseconds at U801-4 (encoder-decoder).

Step 3. Be sure that the receiver sensitivity is within specification. Perform the 20 dBq sensitivity check if not sure.

Step 4. Connect the test equipment as for the 20 dBq sensitivity check, except set the rf signal generator to 1000 microvolts.

Step 5. Connect the "Digital Private-Line" test set CODE OUT connector to frequency modulate the rf generator. Set the test set LEVEL control for ±750 Hz deviation output from the rf signal generator.

Step 6. Set the "Digital Private-Line" test set thumbwheel code switch to the same code as the code plug (mounted on the encoder-decoder board), and set both the ENCODE SELECT and DECODE SELECT switches to select the thumbwheel.

NOTE

Be sure that the test set CODE OUT INVERTED-NORMAL switch is set to the correct position, that the thumbwheel switch is set to the correct code (same as radio set code plug), and that the ENCODE SELECT switch is set to select the thumbwheel setting. The CODE OUT INVERTED-NORMAL position depends upon several variables; e.g., type of signal generator used exact point in the radio set at which the signal is decoded by the test set, and jumper connections in the decoder.

Step 7. Connect a test lead to the test set CODE IN jack. Touch the probe of the test lead to pin 19 of the "Digital Private-Line" Encoder-Decoder board and check that the test set DECODE indicator lights. Set the CODE IN INVERTED-NORMAL switch either up or down as required to light the DECODE indicator.

Step 8. Move the probe of the CODE IN test lead to Q813 collector and check that the DECODE indicator lights.

NOTE

In Step 9 the test set CODE IN INVERTED-NORMAL switch position, with respect to its position in Step 7, depends upon several factors which are summarized in Table 1.

Step 9. Move the probe of the CODE IN test lead to Q807 base and check that the DECODE indicator lights (see Table 1).

Table 1.
CODE IN INVERTED-NORMAL Switch Position

RADIO FREQ. BAND	FREQ. RANGE	2ND OSC XTAL FREQ (MHz)	CODE IN INVERTED-NORMAL SWITCH POSITION OF STEP 9 WITH RESPECT TO STEP 7.
LOW	I & III	2.955	SAME
LOW	I & III	2.045	OPPOSITE
LOW	II & IV	2.955	OPPOSITE
LOW	II & IV	2.045	SAME
HIGH	ALL	12.155	OPPOSITE
HIGH	ALL	11.245	SAME
UHF	ALL	12.155	OPPOSITE
UHF	ALL	11.245	SAME

Step 10. Set the CODE IN INVERTED-NORMAL switch opposite to Step 9. Move the probe of the test lead to Q807 collector and check that the DECODE indicator lights.

Step 11. Check for a logic high at U801-7. If U801-7 is a logic low, set the test set CODE OUT INVERTED-NORMAL switch to the opposite position and check for a logic high.

Step 12. If the results of Step 10 are normal but U801-7 is still a logic low in Step 11 then check encoder-decoder U801 as follows:

a. Check U801-1 for 0 V dc.
b. Check Z801 and the code plug for proper connections, solder shorts, open circuit, etc.
c. Check U801-7 for a short to ground.
d. Check U801-11 for the correct signal signal level (shown on schematic diagram).

Step 13. Decrease the rf signal generator output level to zero and then slowly increase it until the meter 11 position indication is 0.5 V (6 dBq level).

Step 14. Check for a logic high at U801-7.

Step 15. Slowly decrease the rf signal generator output until the meter 11 position indication is .63 V (4 dBq level). Check that the logic high still exists at U801-7.

Step 16. If U801-7 changes to a logic low in Step 15, code sensitivity is low. Check the precision current source.

Step 17. If the radio set has been incorrectly jumpered to the wrong code polarity, all test results will indicate normal operation, but the radio set will not work in its system. Suspicion of such a problem can be confirmed by comparing the "Digital Private-Line" test set code polarity switch settings (normal or inverted) with a record of the settings for normal operation. Since the proper code polarity for testing is dependent upon the type of signal generator being used as well as the factors in Table 1, the record should be compiled using your own signal generator and known good "Digital Private-Line" radios.

5.6.3 Encoder Circuit
(Refer to Figure 9)

Step 1. When checking the encoder circuit while still connected in the radio set, terminate the transmitter output into a dummy load rather than the antenna.

Step 2. Using an oscilloscope, check that the waveform at U801-5 is a 134 Hz symmetrical square wave (approximately 6 V p-p).

NOTE

If the waveform is not correct: check for a 50 kHz square wave clock signal at pin 4 of U801 (code generator-decoder), and be sure that U801-9 is 0 V dc.

Step 3. Check for a 5 V peak-to-peak sine wave at Q801 collector.

Step 4. Set the "Digital Private-Line" test set thumbwheel code switch to the same code as the code plug (mounted on the encoder-decoder board). Set the DECODE SELECT switch to select the thumbwheel.

Step 5. Connect a test lead to the CODE IN jack on the test set. Touch the probe of the test lead to U801-5 and key the radio set. Check that the test set DECODE indicator lights. It may be necessary to reverse the test set CODE IN INVERTED-NORMAL switch position.

Step 6. Move the probe of the test lead to Q801 collector and key the radio set. Check that the test set DECODE indicator lights.

NOTE

If Q803 is not connected in the circuit, be sure that the CODE IN INVERTED-NORMAL switch is in the same position as in Step 5. If Q803 is connected in the circuit, be sure that the CODE IN INVERTED-NORMAL switch is in the opposite position as in Step 5.

5.6.3.3 Delayed Keyed A+/A-

Step 1. Key the radio set and check that A+/A- immediately appears at Q818 collector.

Step 2. Unkey the radio set and check the A+/A- remains at Q818 collector for approximately 180 milliseconds.

5.7 "MOCOM · 10" - "MOCOM · 35" - "MAXAR" MOBILE RADIO SETS AND BASE STATIONS.

Because the "Digital Private-Line" binary-coded squelch used in these radio sets are similar to the "MOCOM · 70" mobile radio set, use the same procedures described in paragraph 5.6

5.8 PORTABLE RADIO SETS

5.8.1 General

The "Digital Private-Line" circuits for portable radio sets are contained on four thick-film hybrid, plug-in modules. Suggested methods for general troubleshooting are discussed below but the reference designations may not apply to a specific equipment.

5.8.2 Initial Check (Refer to Figure 4)

Step 1. Use the "Digital Private-Line" Test Set to check Code Plug Module U134.

Step 2. Perform the 10 dB rise measurement to isolate the rf portion of the receiver from the detector, audio, and decoding circuits.

Step 3. Inspect the flexible circuit connections and measure the B+ and ground connections to each module.

Step 4. Check for regulated +5.2 V at U133-11 and check for a 134 Hz, 5 V peak-to-peak symmetrical waveform at U132-12. (A distorted or off-frequency signal indicates a defective processor module.)

Step 5. Check for a 134 Hz, 5 V peak-to-peak symmetrical waveform at U131-1.

Step 6. Check for a 134 Hz, 1 V peak-to-peak waveform at U131-2 (MX300) or U131-5 ("Handie-Com"). This waveform resembles a sinewave.

5.8.3 Decode Function Check (Refer to Figure 4)

Step 1. Connect rf signal generator of the Motorola Service Monitor (tuned to the receiver rf carrier frequency) to the receiver input. Modulate the rf carrier for ±500 to 1000 Hz deviation with 134 Hz from the "Digital Private-Line" encoder-decoder test set.

NOTE

The 134 Hz signal is generated whenever the test set push-to-talk switch is not activated.

Step 2. Use the service monitor oscilloscope to trace the modulated signal through the Code Conditioner and Processor Modules. A symmetrical 134 Hz square wave should be present at U133 pins 6, 7, 10, and 8, and at U132-10. (If the signal at U133-8 drifts in frequency, or varies in pulse width, pulse shape or in amplitude, the code conditioner is probably defective.)

Step 3. Set the test set thumbwheel code switch to the same code as stamped on the portable radio set code plug. Set the ENCODE SELECT and DECODE SELECT switches to select the thumbwheel.

Step 4. Depress the test set push-to-talk switch and check for a logic high (+5 V) at U133-13 and a logic low at U133-12.

NOTE

Be sure that the CODE OUT INVERTED-NORMAL switch is set to the correct position.

Step 5. If Step 4 results are incorrect, remove power from the radio set and extract the code plug module.

Step 6. Apply power to the radio set and measure the voltage at the code plug socket. Pins 1 through 9 should be 5 V dc and pin 10 should be grounded.

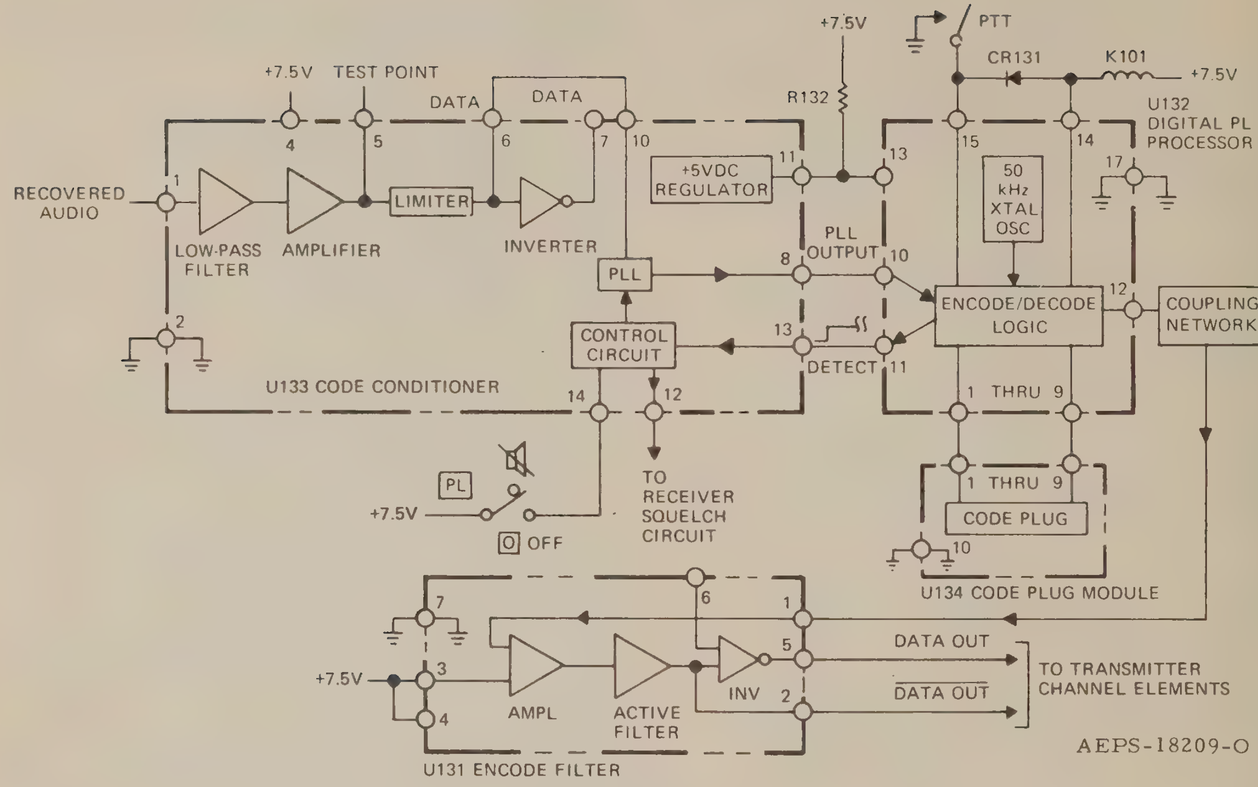
Step 7. If the radio set has been incorrectly jumpered to the wrong code polarity, all test results will indicate normal operation, but the radio set will not work in its system. Suspicion of such a problem can be confirmed by comparing the "Digital Private-Line" test set code polarity switch settings (normal or inverted) with a record of the settings for normal operation. Since the proper code polarity for testing is dependent upon the type of signal generator being used as well as the radio set frequency, the record should be compiled using your own signal generator and known good "Digital Private-Line" radios.

5.8.4 Turn-Off Code Check (Refer to Figure 4)

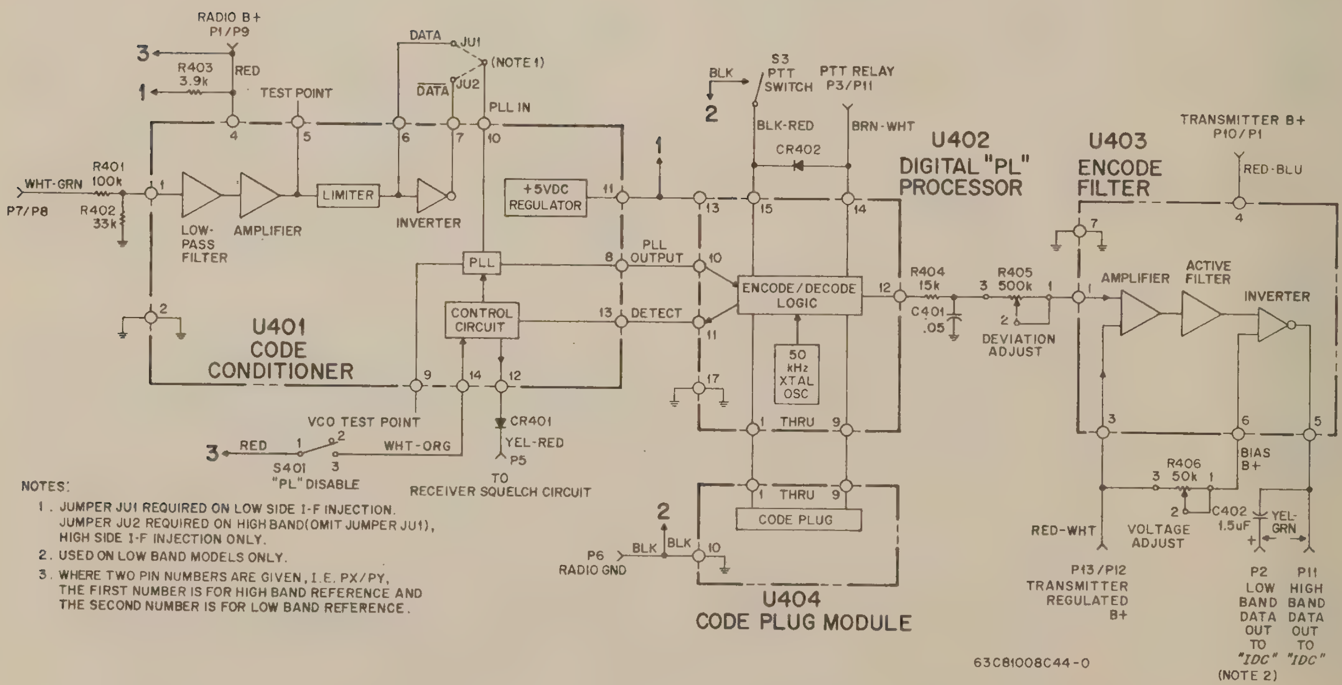
Step 1. Set up the service monitor to receive and display transmitter code from the radio set under test. Press and release the radio set push-to-talk switch several times and observe the waveform on the oscilloscope.

Step 2. When the push-to-talk switch is depressed, the code signal should be displayed on the oscilloscope; however, when it is released, an 80-120 millisecond burst of 134 Hz should be displayed. This should be a sinewave.

Step 3. If the results of Step 2 are incorrect, check external diode CR131 and the associated relay circuit. Replace U132 Processor Module if the external circuits are not defective.



A. MX300 RADIO



B. "HANDIE-COM" RADIO

Figure 4. Portable Products "Digital Private-Line" Circuit, Block Diagram

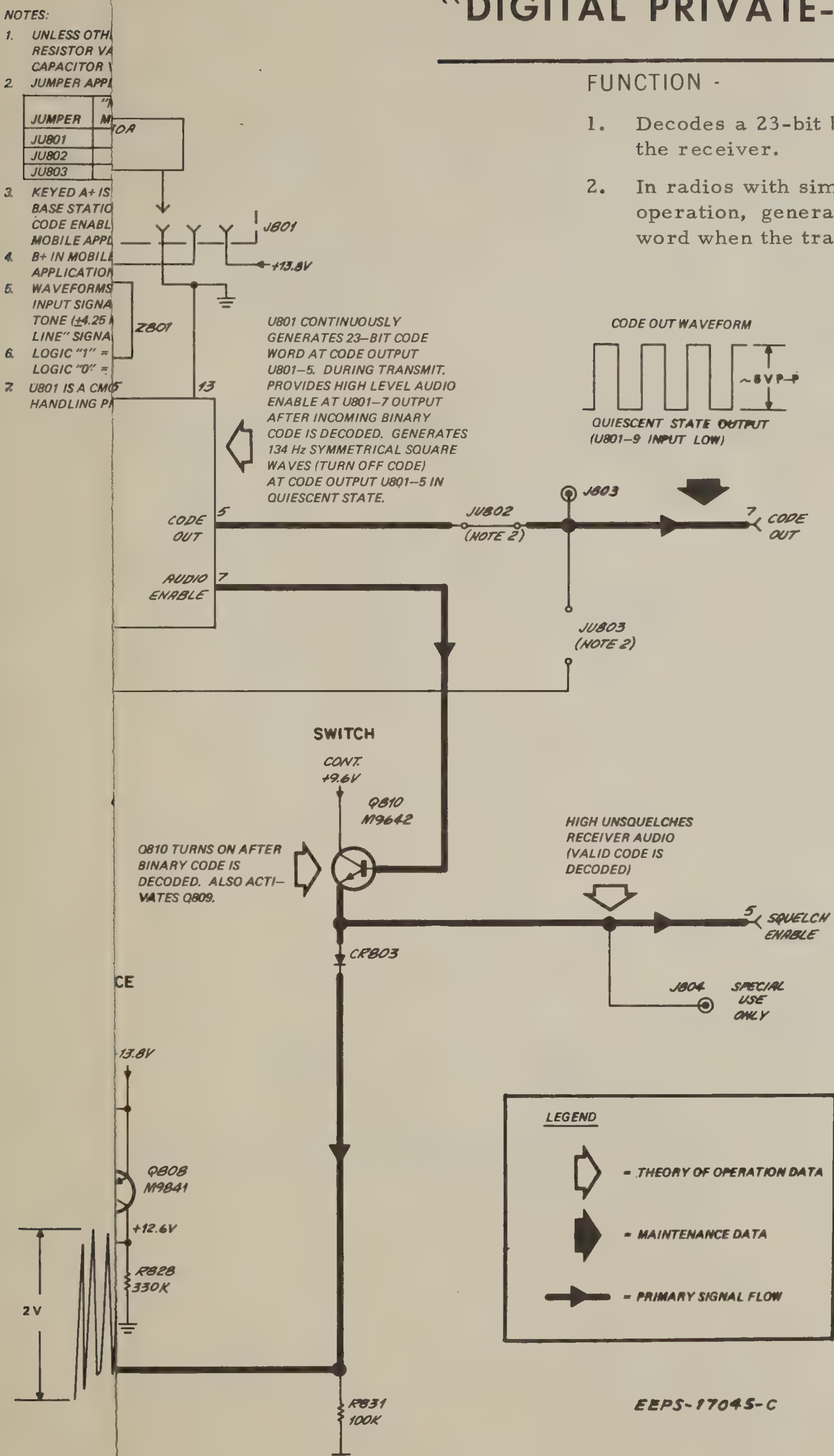
"DIGITAL PRIVATE-LINE" DECODER

MODEL TLN5729A

FUNCTION -

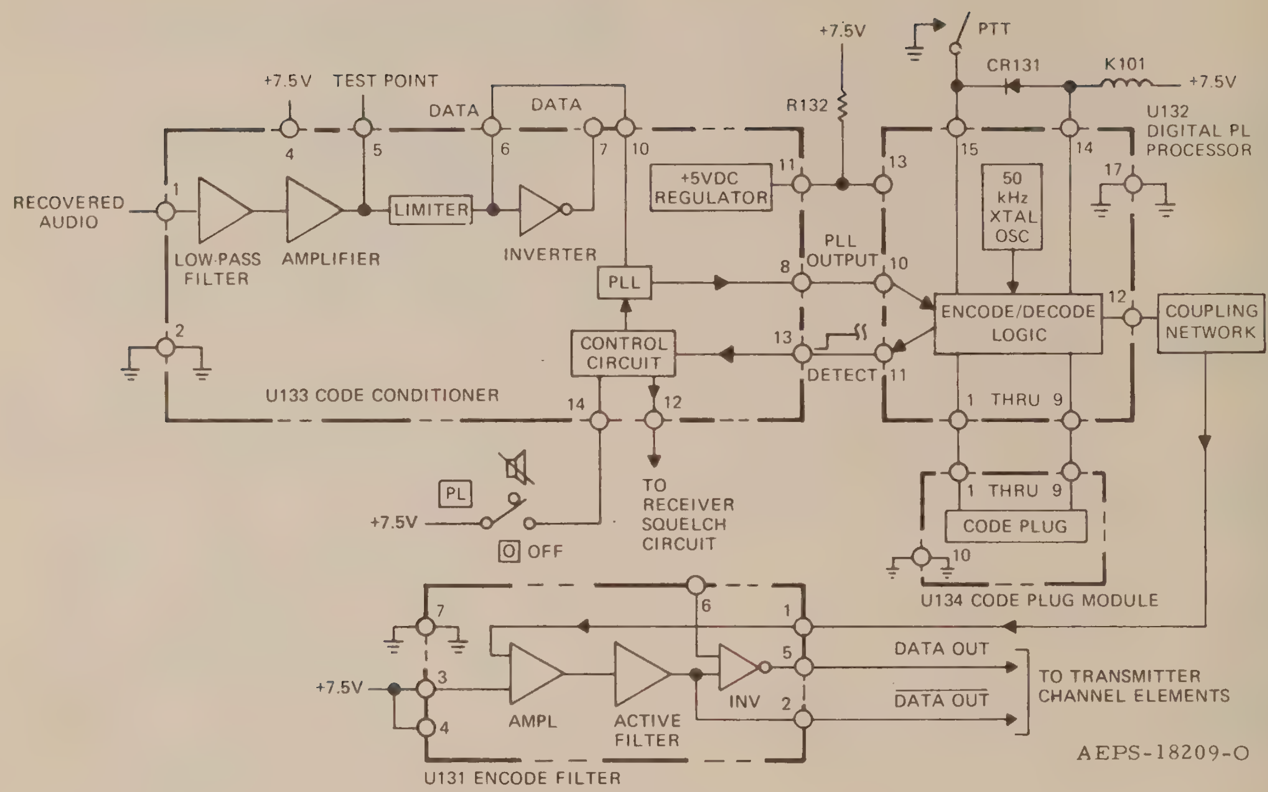
1. Decodes a 23-bit binary code word to unsquelch the receiver.
2. In radios with simplex "Digital Private-Line" operation, generates a 23-bit binary code word when the transmitter is keyed.

NEPS-18204-O

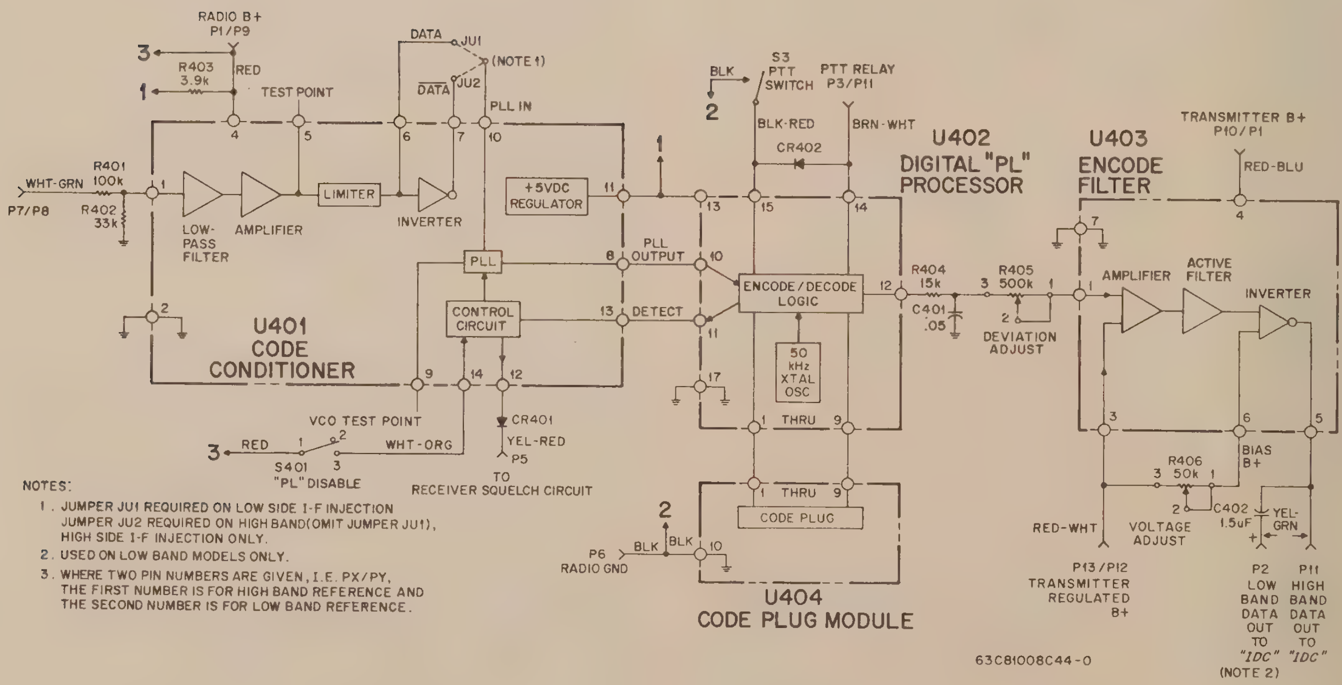


EEPS-17045-C

Figure 5.
TLN5729A "Digital Private-Line" Decoder Schematic Diagram



A. MX300 RADIO



NOTES:

1. JUMPER JU1 REQUIRED ON LOW SIDE I-F INJECTION
   JUMPER JU2 REQUIRED ON HIGH BAND(OMIT JUMPER JU1),
   HIGH SIDE I-F INJECTION ONLY.
2. USED ON LOW BAND MODELS ONLY.
3. WHERE TWO PIN NUMBERS ARE GIVEN, I.E. PX/PY,
   THE FIRST NUMBER IS FOR HIGH BAND REFERENCE AND
   THE SECOND NUMBER IS FOR LOW BAND REFERENCE.

B. "HANDIE-COM" RADIO

Figure 4. Portable Products "Digital Private-Line" Circuit, Block Diagram

"DIGITAL PRIVATE-LINE" DECODER

MODEL TLN5729A

FUNCTION

1. Decodes a 23-bit binary code word to unsquelch the receiver.
2. In radios with simplex "Digital Private-Line" operation, generates a 23-bit binary code word when the transmitter is keyed.

NEPS-18204-O

NOTES:

1. UNLESS OTHERWISE INDICATED:
   RESISTOR VALUES ARE IN OHMS;
   CAPACITOR VALUES ARE IN MICROFARADS.
2. JUMPER APPLICATIONS

JUMPER	"MICOR" MOBILE	"MICOR" BASE (RPTR)	"MICOR" BASE STATION
JU801	OUT	IN	OUT
JU802	IN	IN	IN
JU803	OUT	OUT	OUT

3. KEYED A+ IS APPLIED TO PIN 2 IN "MICOR" BASE STATION APPLICATIONS AND XMIT CODE ENABLE IS APPLIED TO J805 IN "MICOR" MOBILE APPLICATIONS.
4. B+ IN MOBILE APPLICATION, A+ IN BASE STATION APPLICATIONS.
5. WAVEFORMS WERE TAKEN WITH AN ON–CHANNEL RF INPUT SIGNAL OF 1000 uV, MODULATED WITH 1000 Hz TONE (±4.25 kHz DEVIATION) AND A "DIGITAL PRIVATE–LINE" SIGNAL (±750 Hz DEVIATION).
6. LOGIC "1" = 6.0 V
   LOGIC "0" = 0 V
7. U801 IS A CMOS DEVICE. OBSERVE CMOS HANDLING PRECAUTIONS.

TECHNICIANS WHO HAVE NOT PREVIOUSLY SERVICED "DIGITAL PRIVATE–LINE" CIRCUITS ARE INVITED TO ORDER MOTOROLA BOOKLET 68P81106E83 (ENTITLED "DIGITAL PRIVATE–LINE" BINARY–CODED SQUELCH), WHICH COVERS THE FUNDAMENTALS OF SYSTEM OPERATION, CIRCUIT OPERATION AND SERVICING TECHNIQUES. USE THE TEAR–OUT ORDER BLANK AT THE FRONT OF THIS MANUAL TO ORDER YOUR FREE COPY.

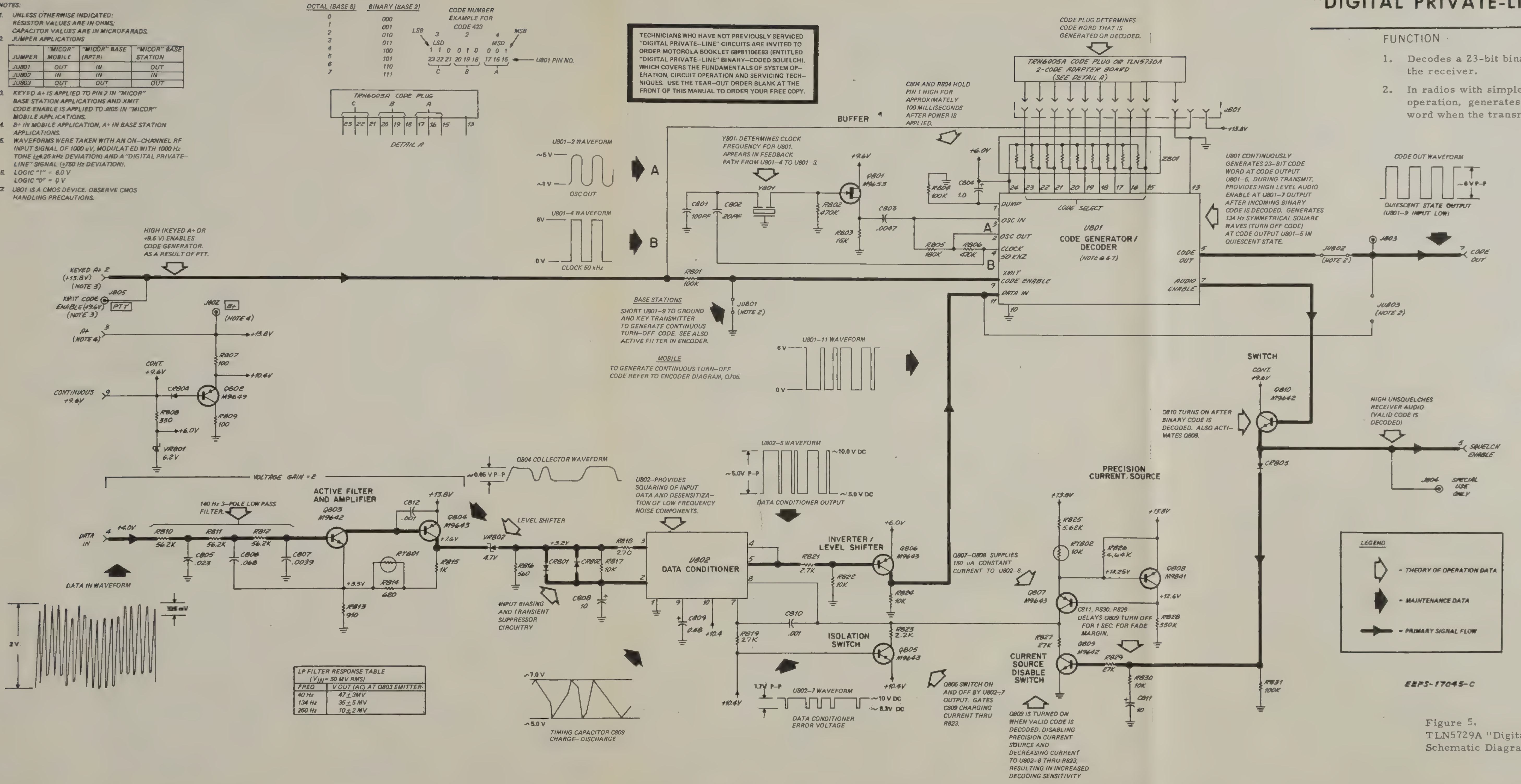
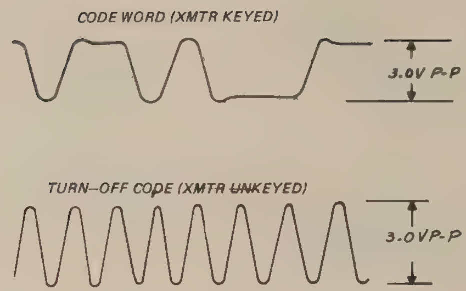
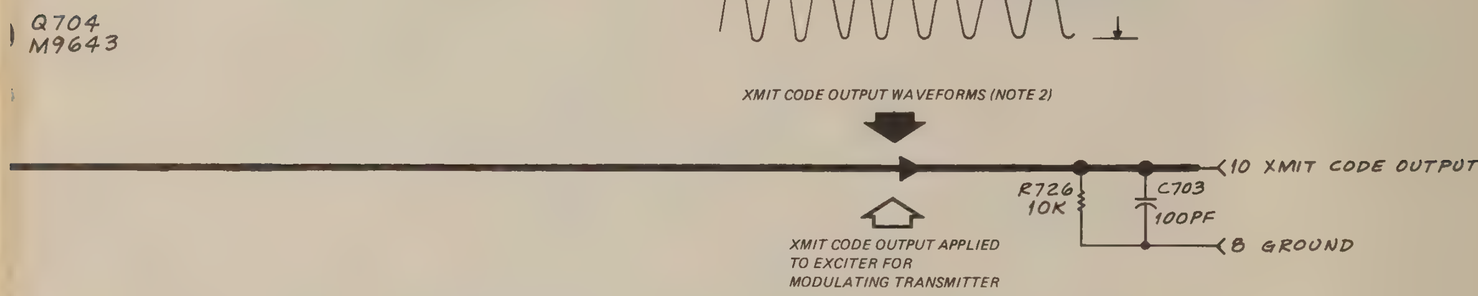


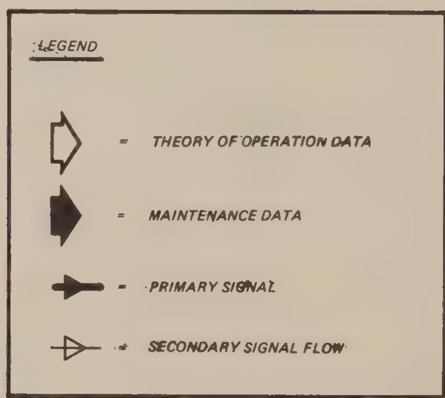
Figure 5.
TLN5729A "Digital Private-Line" Decoder Schematic Diagram

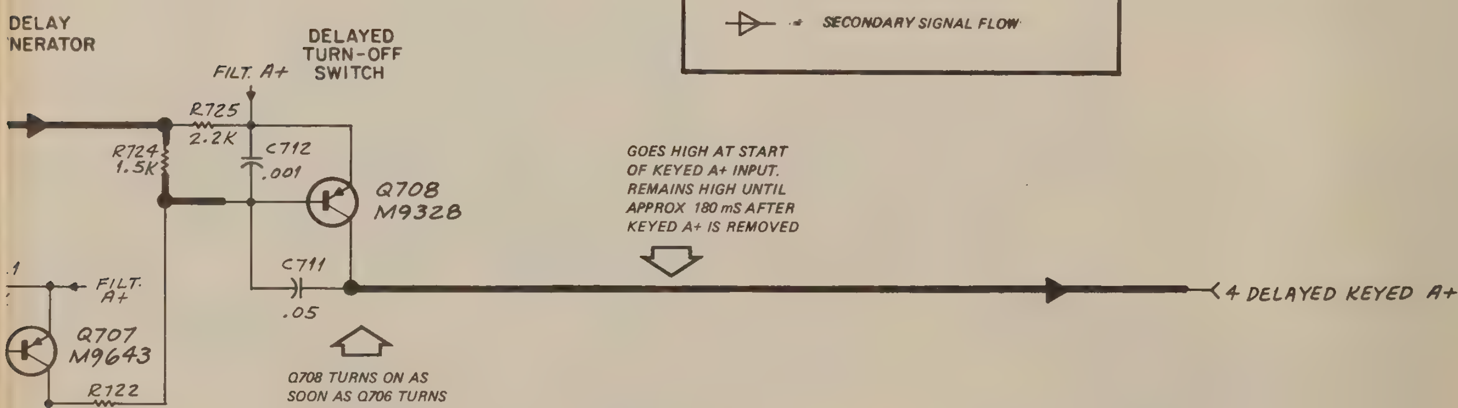
TECHNICIANS WHO HAVE NOT PREVIOUSLY SERVICED "DIGITAL PRIVATE-LINE" CIRCUITS ARE INVITED TO ORDER MOTOROLA BOOKLET 68P81106E83 (ENTITLED "DIGITAL PRIVATE-LINE" BINARY-CODED SQUELCH), WHICH COVERS THE FUNDAMENTALS OF SYSTEM OPERATION, CIRCUIT OPERATION AND SERVICING TECHNIQUES. USE THE TEAR-OUT ORDER BLANK AT THE FRONT OF THIS MANUAL TO ORDER YOUR FREE COPY.





5 IS ON DURING PTT. WHEN ON, Q705 SWITCHES C708 INTO THE
'IVE FILTER TO SHIFT THE -3 dB POINT OF THE FILTER RESPONSE
VN TO ABOUT 85 Hz. WHEN Q705 TURNS OFF, THE -3 dB POINT OF
FILTER RESPONSE SHIFTS UP TO ABOUT 140 Hz. THIS
OWS PROPER TRANSMISSION OF THE TURN-OFF CODE
JING 180 mS FOLLOWING UNKEYING.





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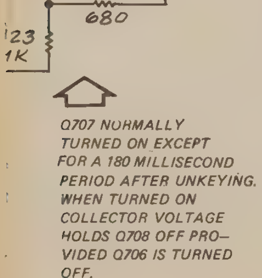


NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS;
   CAPACITOR VALUES ARE IN MICROFARADS.

2. THE Q703-Q704 OUTPUT WAVEFORMS WILL BE CONTINUOUS RATHER THAN SHORT BURSTS. THE SAMPLE CODE WAVEFORM SHOWN IS ONLY A SMALL PORTION OF THE OVERALL.

3. CABLE W1 IS PART OF PAGING OPTION.

DUPLEX "DIGITAL PRIVATE-LINE" ENCODER

MODEL TLN5725A

APPLICATION -

"Micor" Base Stations & Repeaters

FUNCTION-

Generates "Digital Private-Line" code for transmitter in duplex applications (where decoder and encoder may be on simultaneously). Develops 180 mS transmitter turn-off delay (delayed keyed A+).

NEPS-18206-O

IT CODE OUT

AYED KEYED A+

Figure 7.
TLN5725A (Duplex) "Digital Private-Line" Encoder Schematic Diagram

SIMPLEX "DIGITAL PRIVATE-LINE" ENCODER

MODEL TTN6003A

APPLICATION

"Micor" Base Stations with Simplex "Digital Private-Line" Binary-Coded Squelch.

FUNCTION

1. Interfaces code word generator (located on "Digital Private-Line" decoder board) to the exciter, provides low pass active filter for 23-bit binary-code word.
2. Generates delayed keyed A+ (180 millisecond transmitter turn-off delay).

NEPS-18205-O

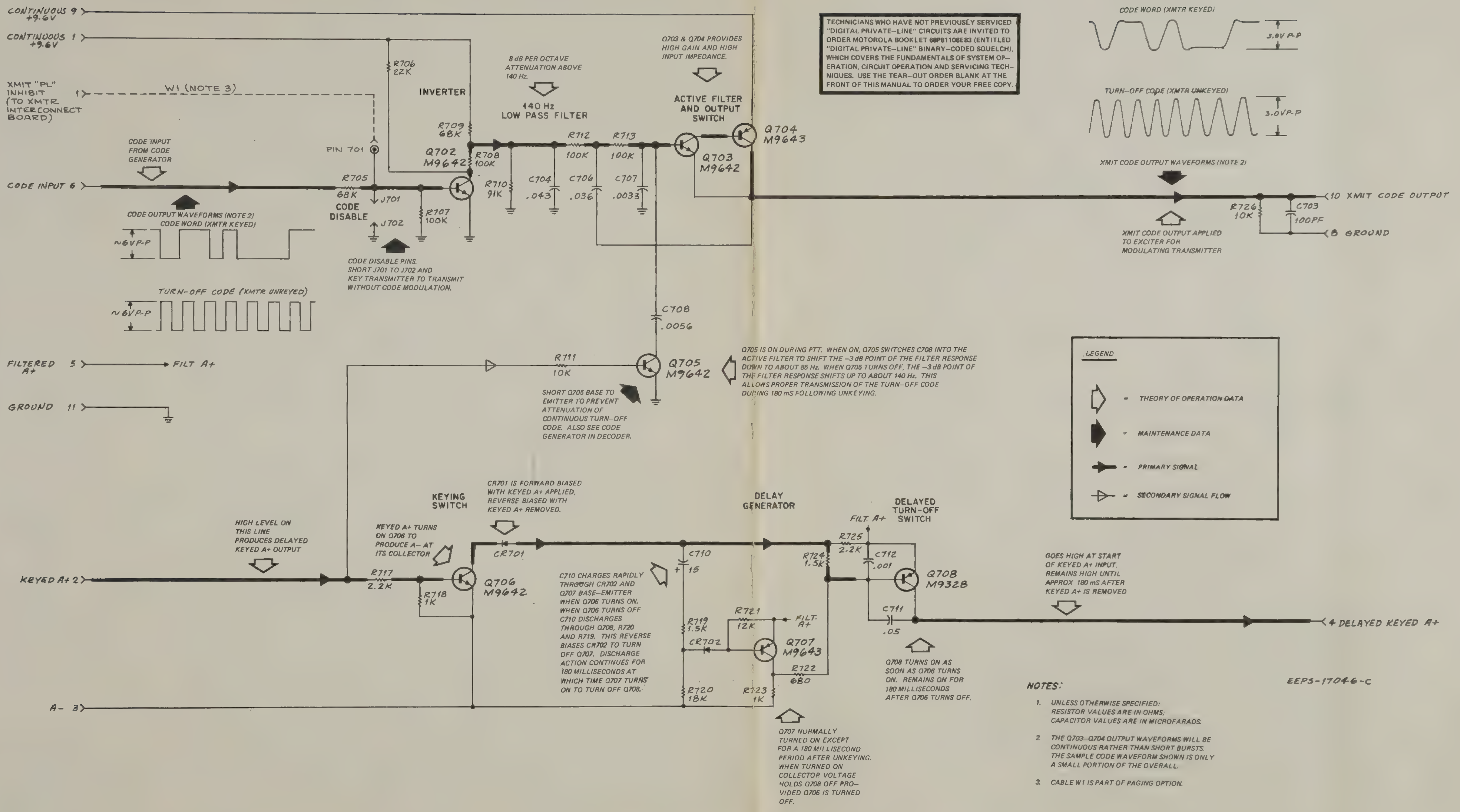
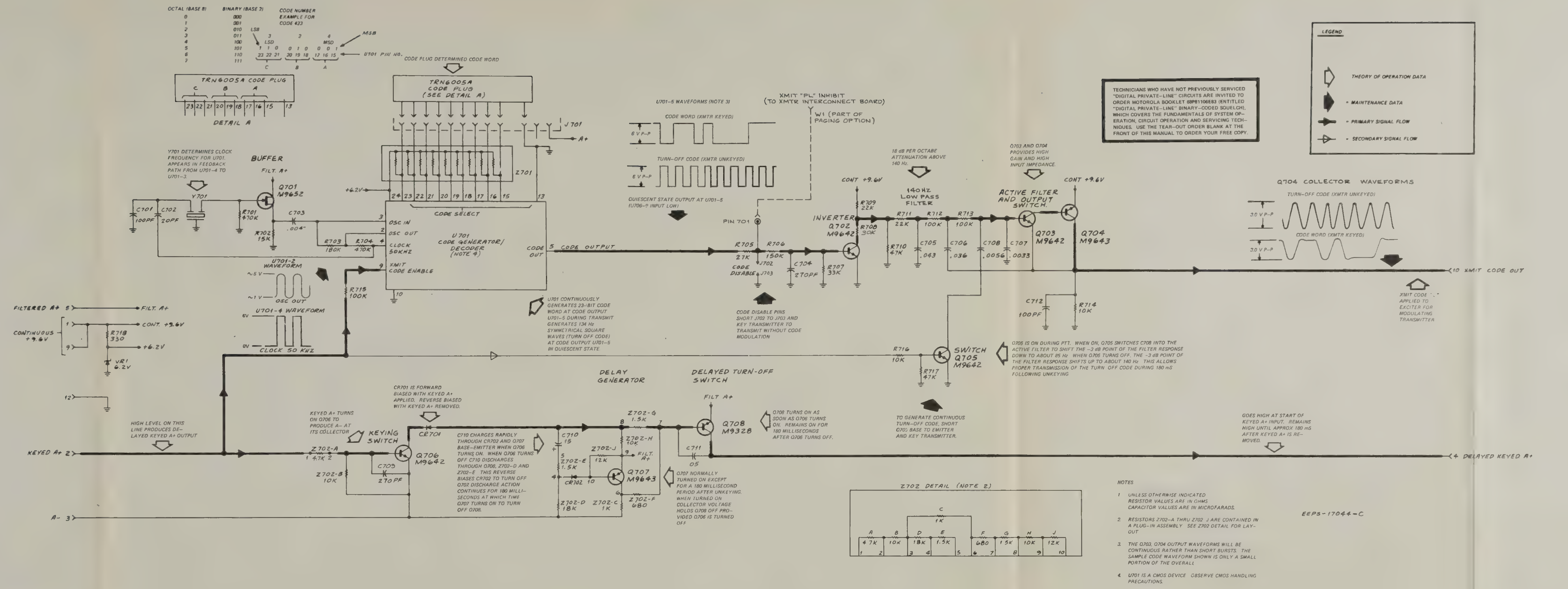


Figure 6.
TTN6003A (Simplex) "Digital Private-Line" Encoder Schematic Diagram



DUPLEX "DIGITAL PRIVATE-LINE" ENCODER

MODEL TLN5725A

APPLICATION ·

"Micor" Base Stations & Repeaters

FUNCTION·

Generates "Digital Private-Line" code for transmitter in duplex applications (where decoder and encoder may be on simultaneously). Develops 180 mS transmitter turn-off delay (delayed keyed A+).

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Figure 7.
TLN5725A (Duplex) "Digital Private-Line" Encoder Schematic Diagram

"DIGITAL PRIVATE-LINE" SQUELCH ENCODER-DECODER

MODELS TLN5817A & TLN5817AV

FUNCTION-

Used as a code generator and decoder in "Consolette" base stations and "Mocom• 70" mobiles. Generates and decodes 23-bit binary-code word in "Digital Private-Line" squelch systems.

NEPS-18208-O

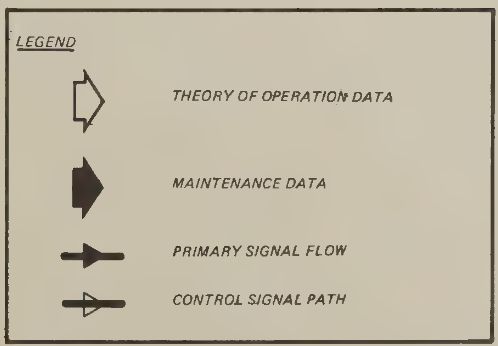

Figure 9.
Model TLN5817A/TLN5817AV "Digital Private-Line" Squelch Encoder-Decoder

SIMPLEX "DIGITAL PRIVATE-LINE" ENCODER

MODELS TLN5723A,TLN5724A,&TLN5726A A

APPLICATION-

"Micor" Two-Way FM Mobile Radios:

TLN5723A Used in 25-50 MHz Radios (Low-Band)
TLN5724A Used in 132-174 MHz Radios (High-Band)
TLN5726A Used in 406-512 MHz Radios (UHF)

FUNCTION -

1. Interfaces code word generator (located on "Digital Private-Line" decoder board) to the exciter provides low pass active filter for 23-bit binary code word.
2. Generates delayed keyed A+ (180 millisecond transmitter turn-off delay).

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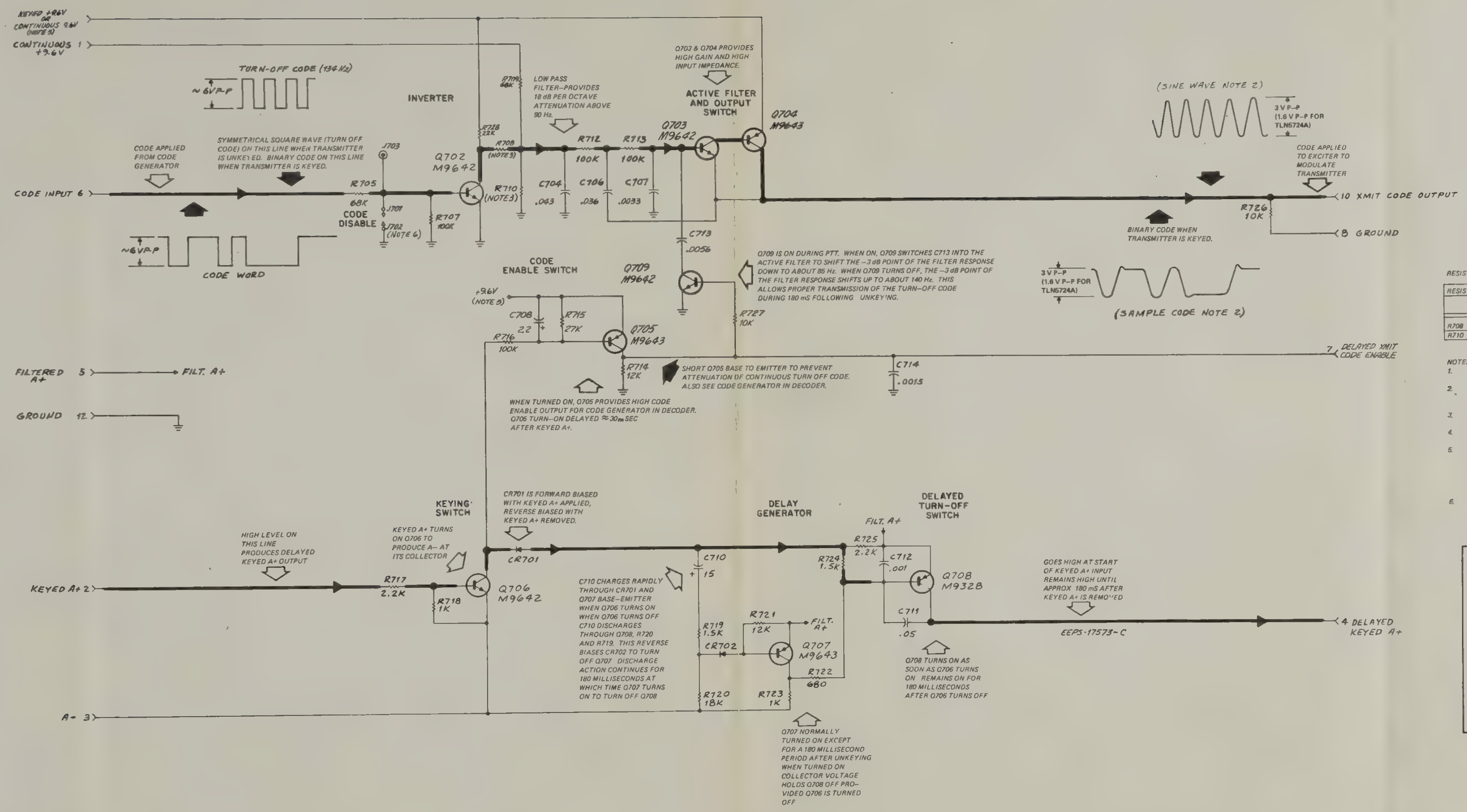


RESISTOR VALUE TABLE

RESISTOR	VALUE, OHMS LOW-BAND (TLN5723A)	HIGH-BAND (TLN5724A)	UHF (TLN5726A)
R708	100K	220K	100K
R710	91K	82K	91K

NOTES

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND CAPACITOR VALUES ARE IN MICROFARADS.
2. Q703–Q704 OUTPUT WAVEFORMS ARE CONTINUOUS, RATHER THAN SHORT BURSTS. THE WAVEFORM SHOWN IS ONLY A SMALL PORTION OF THE OVERALL WAVEFORM
3. REFER TO THE RESISTOR VALUE TABLE FOR THE VALUES OF R708, AND R710 USED IN VARIOUS ENCODER MODELS.
4. C714 IS USED IN MODEL TLN5723A ENCODERS ONLY (LOW-BAND RADIO SETS)
5. KEYED +9.6 V IS APPLIED TO Q705 EMITTER IN ENCODERS USED IN LOW-BAND AND HIGH-BAND RADIO SETS (MODEL TLN5723A & TLN5724A ENCODERS, RESPECTIVELY) CONTINUOUS +9.6 V IS APPLIED TO Q705 EMITTER IN ENCODERS USED IN UHF RADIO SETS (MODEL TLN5726A ENCODER)
6. J701 AND J702 ARE SHORTED TOGETHER BY TRN6332A SHORTING PLUG TO DISABLE CODE WHILE SETTING TRANSMITTER CARRIER FREQUENCY

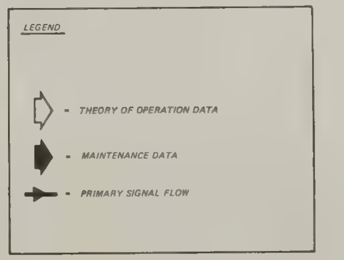


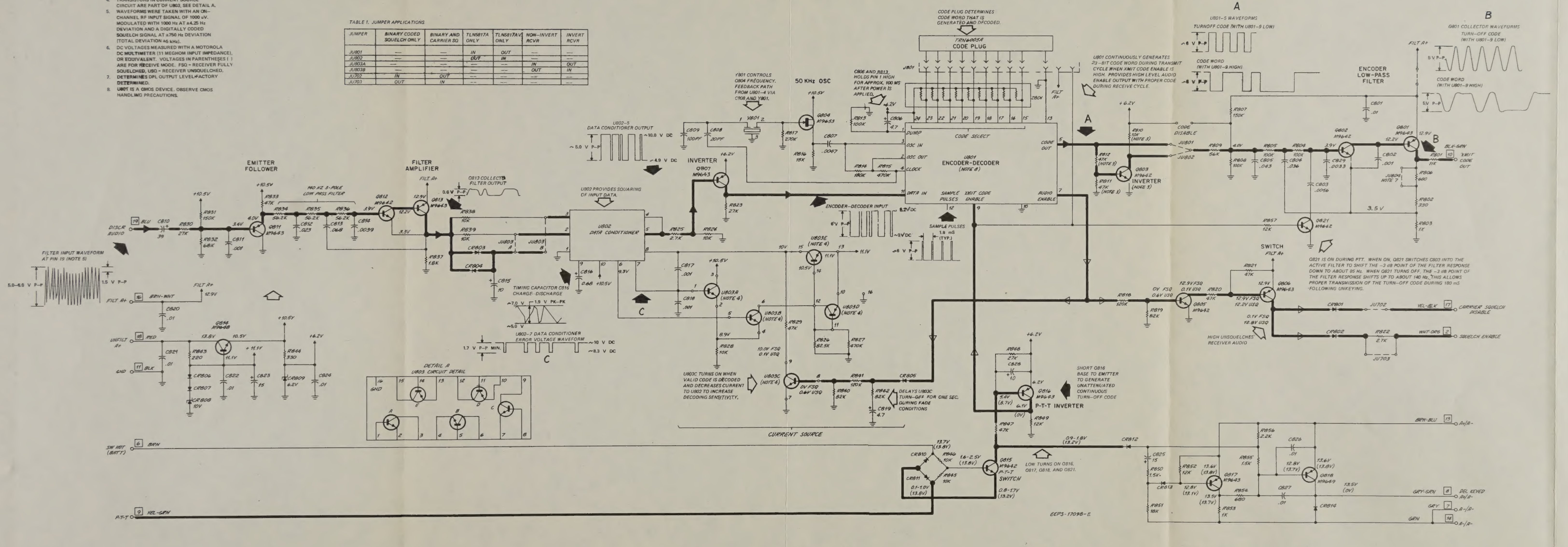
Figure 8.
TLN5723A/24A/26A Simplex Encoder
Schematic Diagram

NOTES

1. UNLESS OTHERWISE INDICATED:
   RESISTOR VALUES ARE IN OHMS;
   CAPACITOR VALUES ARE IN MICROFARADS.
2. SEE TABLE 1 FOR JUMPER APPLICATIONS.
3. R810, R811, R812, AND Q803 USED ON TLN5817AV ONLY.
4. TRANSISTORS IN CURRENT SOURCE CIRCUIT ARE PART OF U803, SEE DETAIL A.
5. WAVEFORMS WERE TAKEN WITH AN ON-CHANNEL RF INPUT SIGNAL OF 1000 uV, MODULATED WITH 1000 Hz AT ±4.25 Hz DEVIATION AND A DIGITALLY CODED SQUELCH SIGNAL AT ±750 Hz DEVIATION (TOTAL DEVIATION ±5 kHz).
6. DC VOLTAGES MEASURED WITH A MOTOROLA DC MULTIMETER (11 MEGHOM INPUT IMPEDANCE), OR EQUIVALENT. VOLTAGES IN PARENTHESES ( ) ARE FOR RECEIVE MODE. FSQ = RECEIVER FULLY SQUELCHED, USQ = RECEIVER UNSQUELCHED.
7. DETERMINES DPL OUTPUT LEVEL-FACTORY DETERMINED.
8. U801 IS A CMOS DEVICE. OBSERVE CMOS HANDLING PRECAUTIONS.

TABLE 1. JUMPER APPLICATIONS

JUMPER	BINARY CODED SQUELCH ONLY	BINARY AND CARRIER SQ	TLN5817A ONLY	TLN5817AV ONLY	NON-INVERT RCVR	INVERT RCVR
JU801	—	—	IN	OUT	—	—
JU802	—	—	OUT	IN	—	—
JU803A	—	—	—	—	IN	OUT
JU803B	—	—	—	—	OUT	IN
JU702	IN	OUT	—	—	—	—
JU703	OUT	IN	—	—	—	—



"DIGITAL PRIVATE-LINE" SQUELCH ENCODER-DECODER

MODELS TLN5817A & TLN5817AV

FUNCTION-

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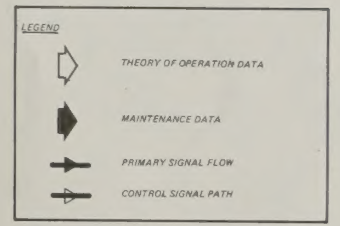

Figure 9.
Model TLN5817A/TLN5817AV "Digital Private-Line" Squelch Encoder-Decoder

"DIGITAL PRIVATE–LINE"
BINARY–CODED SQUELCH
Theory and Servicing Fundamentals

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